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LIBRARY MANAGEMENT SYSTEM

– Developed with a project planning and quality management approach

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BACHELOR'S THESIS | ABSTRACT

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A library is where knowledge is preserved. The importance of libraries is undeniable, especially in an academic environment. With the vast growth of technology, managing a library could be made easier. One solution is to create a web-based library management system using modern web technologies.

For a project to be successful, project management plays an irreplaceable role. Project management includes several components, of which project planning remains one of the key factors. Besides, quality management adds up substantial values to the project, bringing its overall results to a higher standard.

The goal of this thesis was to investigate the process of creating a library management system using web technologies, which was implemented using project planning and quality management methods. The six steps of creating a project plan are studied, which include breaking down the deliverables, pointing out dependencies, estimating time, adding contingency, considering risks and representing the plan to stakeholders. In addition, certain quality management methods are introduced, incorporating both technical and non-technical strategies to enhance the application's quality. The functions of the library management application are formed with modern web technologies, of which PHP is the primarily used language.

The results of this thesis are reflected on the functioning library management application, which was built by utilizing the methods mentioned previously. The way the application works and certain functions are specifically explained. This thesis concludes the overall impacts of project planning and quality management on the library management system. Further development suggestions are proposed.

KEYWORDS:

Library management system, Project planning, Quality management, PHP, Web-based application

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LIST OF ABBREVIATIONS

API	Application Programming Interface
CSS	Cascading Style Sheets
HTML	Hypertext Markup Language
ISBN	International Standard Book Number
LMS	Library management system
PHP	Hypertext Pre-processor
SQL	Structured Query Language

1 INTRODUCTION

Books have long been the source of knowledge for humanity. Thus, a library where books are well preserved certainly plays a significant role. However, with a large number of books, it may be difficult to maintain and manage them manually. Therefore, library management systems were created to solve this problem.

The author completed an internship in a computer laboratory in Sendai National Institute of Technology, Japan. In a school's laboratory, a miniature library would often exist and serve as an important reference point for numerous students. Despite being small, the laboratory library still took much time and effort for the supervisor to track who had borrowed books, which books were available and which books had not been returned. Realizing this problem, the supervisor of the laboratory provided a project topic to the author, which was to build a library management application using web technologies.

The basic requirements of the project are:

- To create a user with administrative functions in order to manage books, issue books and keep track of records efficiently.
- To help students view the available books and manage their book loans.
- To build a product that can run locally on the supervisor's computer.
- To make sure the application is easy to use with logical connections between different functions.

A project's success, however, depends on various factors. One of the most noticeable factors is project planning. "Planning is arguably the most important phase of your project" (Williams, 2008). Thus, the project planning phase of this project will be investigated. Moreover, during most projects, quality management is a mandatory step to be executed during the product development process before it is ready to be delivered to the customer. This thesis will look into quality management methods and the implementation of them to the library management application.

During the internship period, the author managed to develop a functioning library management application. Nevertheless, throughout the time spent on this thesis, the author put in additional details to improve the application by utilizing project planning and quality management methods. This thesis will present the process of developing such

an application, regarding the front-end, the back-end, the logic behind, the impacts of project planning and quality management methods, as well as the technologies involved.

There have been other theses that analyzed similar topics compared to the ones the author proposed. Jin (2011) examined the development of a library management system from PHP and MySQL through her thesis “Web-Based Library Management System with PHP and MySQL”. Anuj (2019) published his thesis “Library management system – For Butwal High School” which described the theoretical process of creating the library management system. Vikas (2017) dived deep into project quality management for the information technology sector through his thesis “Project Quality Management for IT company”. This thesis, however, discusses the practices of project planning and quality management, which are reflected in the results of the library management system.

To demonstrate the process and the above-mentioned objectives, this thesis is composed of five chapters. The first chapter briefly introduces the importance of a library management system and its initial requirements, together with project planning and quality management. Chapter 2 discusses the background need for a library management system, the significance of project planning and quality management in a project. Chapter 3 discusses the methodology and theoretical knowledge that the topics of this thesis involve. Chapter 4 guides through the design and implementation process to achieve the desired goals for the library management system. Chapter 5 presents the conclusion and discussion about future possibilities to advance the application.

2 RATIONALE

A library management application is a technical project, to which project management should be applied extensively. Project management includes several key stages, out of which project planning and quality management play irreplaceable roles. This chapter goes into the background needs for a library management application, the emphasis on proper project planning and the values of quality management in this project.

2.1 Background needs for a library management application

Books undoubtedly are the bridge to knowledge and culture. Managing books, thus, becomes a top priority in all facilities that store books as a source of information. A library management system (LMS), accordingly, is essential for several compelling reasons. First of all, an LMS improves overall efficiency and productivity. Librarians can take control of the books without manual work, which indeed reduces substantially human errors as well as repetitive tasks. Secondly, an LMS saves an abundant amount of time. With the work automated and digitally sorted out, the librarian will find the desired books and its availability much faster. Likewise, this also applies to the student. Hence, both individuals benefit from the system. Last but not least, an LMS serves and suits this generation's students. In this modern day and age, information is not difficult to find, but difficult to filter and decide which piece of it is trustworthy. To comply with the fast pace of young students, an LMS would be a reliable place where students can quickly search for the books that relate to the topics they are interested in with minimal effort (Datir, 2018).

As mentioned in the previous chapter, the author finished an internship at a computer science laboratory in Japan where the needs for an LMS emerged. All of the above reasons meet the laboratory's needs. In addition, the LMS studied in this thesis will be built as a web application. This stands as another advantage because a web-based solution will require no software installation and this will provide easy access across devices.

2.2 Project planning's role in project management

Project management consists of several phases. After project initiation, project planning comes as the next crucial step. "We plan at the beginning to save time later" (Project Manager, 2020). There are a number of convincing grounds for project planning:

- to grasp the project as a whole
- to communicate clearly with the project owner to agree about how the project is approached
- to find out the best approaches to solve the problem
- to provide guidance and an outline to monitor progress

Without project planning, it may become challenging to control the project. Even though a project plan is not as detailed as a to-do list and cannot replace one, it indeed emphasizes the key directions of where the project is heading. With good project planning, time will be allocated suitably for each phase and task of the project. Possible risks and dependencies should also be listed out in a project plan so that the solutions for the unexpected situations that may come up are already discussed or brainstormed. A project plan helps everyone that is involved in the project (known as stakeholders) to agree on the outcomes, hence avoiding any conflicts later about the deliverables of the project (Williams, 2008).

2.3 Quality management's role in the project

Quality management is a key factor in the overall success of a project. The Project Management Institute (2004) defines quality as "the degree to which a set of inherent characteristics fulfill requirements." To ensure a project's quality, every individual involved in the project bears the responsibility and commitment to fulfil the quality requirements of the project. The individual assigned for quality assurance will oversee the overall situation and make sure everyone in the team comprehends the customer's expectations of the project's quality.

There are many justifications why special attention should be paid to quality management. First of all, a product that stands out in its quality earns the customer's satisfaction and improves the user experience. Cost efficiency is another reason, because a quality process may lead to reduced cost, which in turn translates into

potential growth in profits. Additionally, good quality management results in boosting competitiveness, especially in such a global world that is expanding rapidly. (Rose, 2005).

According to a study of the American Society for Quality, every $1 invested in Quality management generates $16 in cost reduction and a $3 increase in profit (ISOUpdate, 2018). Investing time and effort in quality management is a reliably valid action to enhance the general outcome of a product in a positive way.

3 METHODS OF PROJECT PLANNING AND QUALITY MANAGEMENT

To develop a product in general, or a digital product to be specific, proper project planning remains one of the major preparation steps. When it comes to overall customer satisfaction, quality management will be a crucial aspect to be considered. This chapter focuses on the importance of project planning in creating an LMS as well as the quality management methods that ensure the LMS's quality is up to standard.

3.1 Project planning in the library management system

Project planning, according to Williams in "The principle of Project Management" (2008), includes six steps:

- break down the deliverables
- point out dependencies
- estimate time
- add contingency
- consider risks
- represent the plan to stakeholders

Deliverables, in simpler words, can be understood as goals of the project. However, goals may sound general and have broad coverage. Breaking down deliverables means describing the goals to the detailed level. In the case of an LMS, a breakdown of deliverables can look like this (Figure 1):

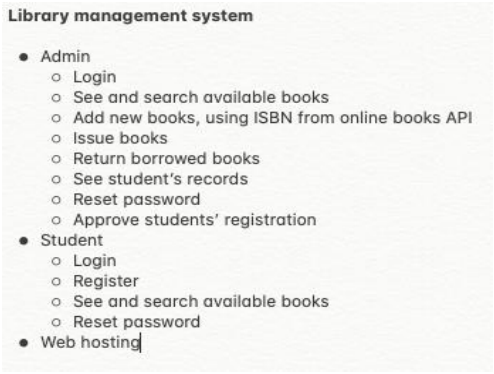

Figure 1. Deliverables breakdown.

The second step would be identifying dependencies. This means to define the dependence of deliverables on each other (Williams, 2008). This step helps to realize the gaps in the initial deliverables breakdown. Below is an example of the LMS's dependency flowchart:

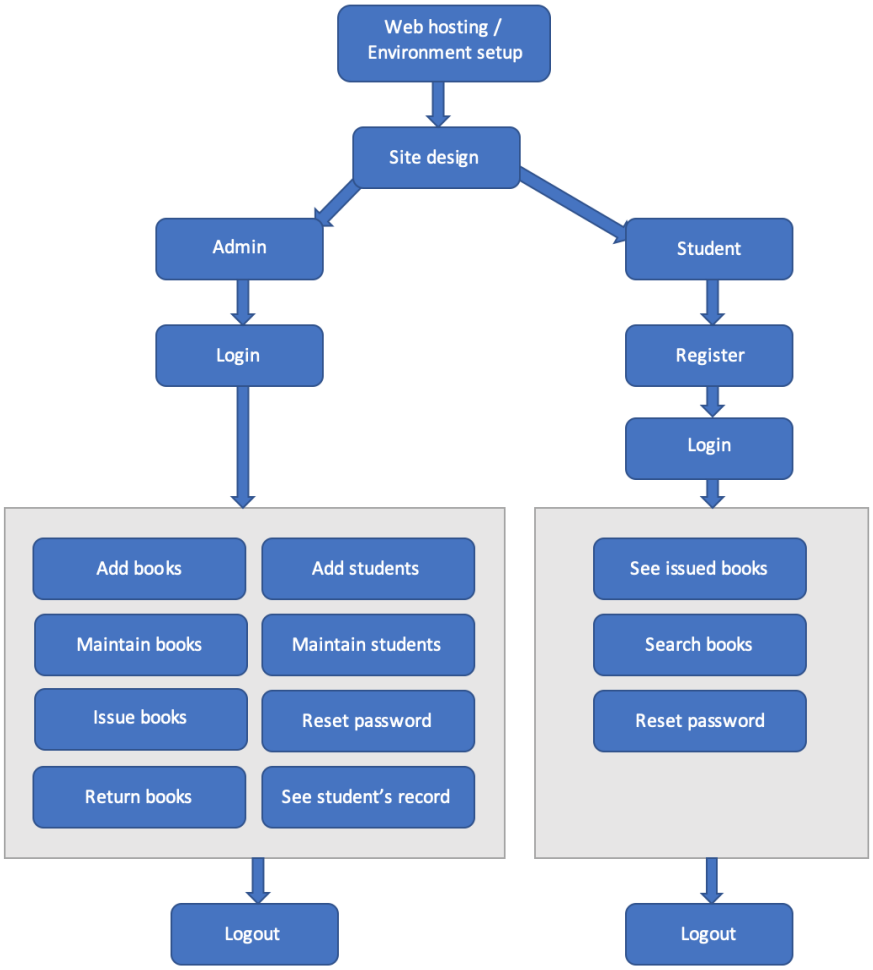

Figure 2. Dependencies chart.

The third step is to estimate how much time it would take to finish the project and more ideally, to finish each deliverable (Williams, 2008). The author conducted the work alone on this project and was given a fixed time frame of three months to get it ready. Consequently, the author set up a schedule that would be the most fitting with the requirements:

- Researching technology: 2 days
- Building the database relationship: 3 days

- Researching about user interface and sketching wireframes: 1 week
- Setting up the environment: 2 days
- Developing the front-end: 1 week
- Developing the back-end: 3 weeks
- Reviewing, testing and fixing: 3 weeks
- Quality testing, presenting the work, closing the project: 1 week

After estimating time, it is important to also consider the contingency and the risks involved (Williams, 2008). Contingency means the extra time that is reserved for unfortunate or unforeseen events that may become blocking obstacles to the project. The above schedule leaves out 2 weeks for this matter. Moreover, risk assessment should be examined thoroughly at the beginning of the project. A risk management plan could be created with these steps:

- Find out potential risks
- Decide which ones are more likely to happen and create more damage
- Choose the most threatening risks to plan for

(Williams, 2008)

Potential risks that the author mapped out for the LMS project are as followed:

Risk	Probability	Danger	Overall
Project owner does not offer opinions about the project's design	3	3	9
Natural disasters (e.g. earthquakes) that may delay or lengthen the project's allocated time	3	5	15
The environment has problems with database connection	3	4	12

Figure 3. Risk rating table.

The most severe risk that might happen is that there will be unexpected events, e.g. earthquakes which happen frequently in Japan, which may delay or lengthen the project's allocated time. If this event were to occur, one solution could be to define feature prioritization from the beginning of the project. The MoSCoW method can be applied to

this situation. This method helps to define and manage requirements in a project by prioritizing them on different levels. There are four categories for this method which follow an order, including must-have requirements, should-have requirements, could-have requirements and what we will not have this time (Madsen, 2019). By defining these requirements early on the project, in case the risk becomes a reality, the project's features will be implemented in the order of the MoSCoW method. Another solution could be to ask for more resources from the beginning of the project such as getting another student to work on this project together with the author to speed up the project process.

Finally, the project plan will be presented to the project owner and other stakeholders to check and approve. The key aspects that the project plan will contain are deliverables, a schedule, assumptions of time as well as contingency and a risk management plan (Williams, 2008). An example of the project plan can be found in the Appendix section.

3.2 Quality management in the library management system

3.2.1 Quality management definition and methods

Quality management definition

Quality management is the act of controlling activities that must be achieved, which leads to a desired level of brilliance in a product. Quality management involves the decision of a quality policy, generating and implementing quality planning and assurance, quality control and quality improvement (Barone, 2019).

Quality management methods

To improve a project's quality, possible measures vary in multiple aspects. The expectations for a project's quality can be roughly divided into two groups, according to Kainulainen (2010). The first group involves appearance, where stakeholders pay special attention to the functions and user interface of the product. To satisfy this group's expectation of quality, the product needs to work smoothly as well as possessing an attractive user interface. The second group, on the other hand, puts considerable

emphasis on the implementation of the product. The stakeholders in this group are mostly concerned with readability, maintainability and testability of source code.

Quality management has three major processes that are carried out throughout the project process, which includes plan quality, quality assurance and quality control (Martinez, n.d). A list of quality management questions which provides guidance for the three processes that can be applied throughout the project can be found below:

Plan quality (before the project)

- What project process are you following?
- Do you have an initiation document? Where is it stored?
- Do you have a project plan with goals, schedule, quality goals and risk analysis? Where is it stored?
- Are you clear on your role and what you should be working on?
- How do you make sure you achieve the quality goals that are written in the project plan?
- Are the customer's requirements clear?

Quality assurance (during the project)

- How good is the communication between you and your team/ project owner?
- Is what you are doing the most time-effective and cost-effective?
- Are you following the schedule tightly? Do you need to add any changes to the initial plan?
- Are there continuous improvements?
- How often do you communicate with the customer during your project? Are the requirements the same or changed? How have you been able to keep up with them?

Quality control (after the project)

- Do you have a project closing with your team? Where is it stored?
- Do you have a final report? Where is it stored?
- Do you already have customer feedback? Where is it stored?
- Do you have peer reviews and testing? If yes, how were they done? If not, why not?
- Do you meet the quality goals?
- Are there any lessons learned?

3.2.2 Quality management practices used in the library management system

Appearance

Correspondingly to the previously mentioned aspects: appearance and implementation, several strategies in quality management can be used to improve the LMS's quality. With regards to the appearance, wireframes and design consistency were the focused points.

Simple wireframes for the user interface before the project is implemented are a provenly effective way to enhance the look of the project. Before developing an application, it is advisable to sketch the user interface of that application first so the developer can form an idea of what will be implemented for the front-end. Wireframing serves this purpose. It designs the website on a structural level. In the early phase of development, wireframes provide the basic visuals of the application that may as well communicate the functionalities of the product. A wireframe format, in comparison with developing the whole application, is faster and simpler to make, thus making it a great tool to deliver the concept design to the customer. It also builds a profound base to help move forward with the application (Guilizzoni, n.d). An example of a wireframe can be found in Figure 4 (Babich, 2017).

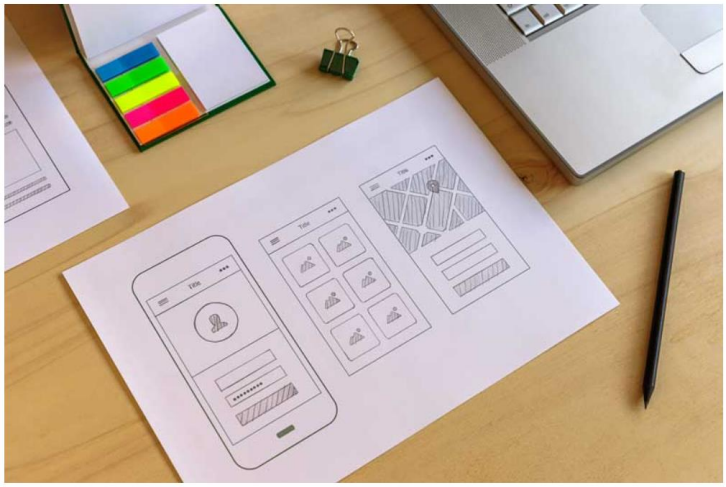

Figure 4. Example of a wireframe (Babich, 2017).

Another point to notice is the layout and design consistency of the project (Meiert, 2016). Design consistency is the act of creating a uniform look for repeating elements

throughout the website. To achieve this, the design of typography, graphics, colors, icons and buttons should be harmonious (Burt, 2017).

Implementation

When it comes to the implementation of the product, various techniques in quality management may be carried out. According to Meiert (2007), significant steps to create a quality website include but not limited to planning, information structure, programming-related notices, and quality assurance methods. Planning a website well helps to define the goal, target audience, content and key metrics to measure the website's success. Equally important, the structure and architect of the site should be created, tested, verified and reconsidered before any code is written. After going through the design phase, programming-related points should be carefully considered. Structured code that follows the coding guidelines are highly appreciated. Web accessibility which makes web content more accessible for disabled people is also a dominant factor to comply with Web Content Accessibility Guidelines (WCAG), thus satisfying stakeholders' requirements for quality in this aspect. Last but not least, quality assurance should be launched throughout the process. Examples for this strategy could vary from functional testing to performance testing, security testing, compatibility testing and content testing (Kang, 2020).

Documentation

For a project to succeed, documentation makes substantial contributions. According to Majeed from project-management.com (2012), "nothing is more important than keeping documentation" in project management. To justify this statement, several argumentations can be taken into consideration. Documented decisions provide reliability for a project and prevent repetitive discussions over the same problems (Alam and Gühl, 2016). Documents, hence, are the reference point providing proof of important data. Goals and milestones are written down in documentation, thus making it easier to measure the progress. Additionally, documentation also helps to point out the reasons for poor performance, which can result in valuable lessons that can be applied to future projects. Documentation prepares the project for unfavorable situations such as obscure risks or sudden changes. Another point to mention is that documentation helps to prevent

unwanted troubles (Alam and Gühl, 2016). Not only does it clearly draw the responsibility for the people involved but it also helps to avoid contradictions. One could possibly claim that documentation increases the success rate of a project, since decisions made in the project will be based on the concrete facts that were documented. Therefore, all the documents related to the LMS including project initiation, project plan, status update, project closing, final report as well as customer feedback were carefully made and restored on a cloud folder that all stakeholders of the project have access to.

Communication

Communication is undoubtedly a crucial process not only in our daily life but also in project management, especially when it comes to improving a project's quality by ensuring communication between stakeholders of the project is clear. An effective communication plan is needed to maximize the success possibility and minimize the risks that may happen because of poor communication. According to Abudi (2013), a communication plan made at the beginning of the project should answer these questions:

- What is being communicated about? (e.g., status update)
- When is communication happening? (e.g., every Friday)
- Who are you communicating with? (e.g., project owner)
- How will you communicate? (e.g., emails)
- What format are you using to deliver your message? (e.g., reports, presentations)

In this modern era, the channels for communication are made convenient. Suggestions for means of communication may include one-on-one meetings, small group meetings, all-team meetings, lunch, before or after hours get-togethers, internal board established specifically for the project, email, chat, project newsletters, virtual meetings, etc.

For the LMS, it was agreed that the project owner and the author would have a face-to-face meeting on every Friday afternoon at 15:00 to discuss about the status of the project. Other discussions related to the project would be made through emails.

Quality management questions checklist

A tactic used in the LMS was to keep up with the list of quality management questions in chapter 3.2.1. By answering the afore-mentioned questions, the project would be

developed in an oriented way that would have a positive impact on the project at a general level. The checklist was wide enough to convey the quality standards, practical enough for stakeholders to use easily throughout the project and clear enough for everyone in the project to have the same understanding. Furthermore, the questions put a strong emphasis on documentation, which undoubtedly helps to record information in a systematic way that would benefit the project in the long run. Naybour (2016) stated that a systematic procedure brings multiple values:

- Effective decision making by having clear roles and the responsibilities as well as authorities attached to those roles.
- Saving money and time by having a road map for the project, supported by a common set of processes that are used repeatedly, which leads to a boost in the processing time, thus saving money.
- Control over the project scope to manage time and cost efficiently.
- Clear expectations for the client by having everyone involved in the project to agree on the deliverables upfront.
- Better problem resolutions by careful risk planning and continuous communication.
- Controlled costs by a defined time and cost estimates.
- Quick identification of problems.
- Motivated team members as a result of a better controlled project with fewer unexpected surprises.

4 DESIGN AND IMPLEMENTATION OF THE LIBRARY MANAGEMENT SYSTEM

After carefully drafting the project plan and obtaining quality management approaches, the LMS was created following the top-down approach in design. This means the development of the product happens at the end of the process after substantial research and planning have been conducted (Maxey, 2012). This chapter will study the technologies that were used and the implementation of the LMS to achieve the desired deliverables that were mentioned in the project plan in chapter 3.1.

4.1 Technologies used

HTML

HTML stands for "Hypertext Markup Language". It is used to structure web pages and their content. HTML is not a programming language but a markup language. It consists of elements that make the content appear in a certain way such as heading, paragraphs, lists, links and more. (MDN web docs, 2019)

CSS

CSS stands for "Cascading Style Sheet". It is used to format the layout of web pages in browsers. CSS helps with creating a uniform look of the website. With the use of CSS, developers gain more control in deciding exactly how websites look like. That explains why the majority of websites incorporate cascading style sheets. (TechTerms, 2006)

Javascript

Javascript is a dynamic computer programming language. Javascript's syntax is influenced by C. JavaScript is a client-side scripting language (TechTerms, 2014). It should not be confused with Java because the two languages are unrelated and have

significant differences in syntax, semantics, and uses. Javascript has recently become one of the most popular programming languages. (MDN web docs, 2020)

Bootstrap

Bootstrap is an open-source front-end development framework. It was developed at Twitter, using CSS, HTML and Javascript libraries. Bootstrap helps developers to save time by building responsive websites without the need to start from scratch. Bootstrap's compatibility with all modern browsers (including newer versions of Internet Explorer) is a big advantage. (Bootstrap, n.d)

PHP

PHP stands for Hypertext Preprocessor. It is an open-source scripting language that is used for general purposes. PHP is widely used and suitable for web development. It can also be embedded in HTML. PHP differs from Javascript, most distinguishably in the fact that the code is executed on the server, making it a server-side scripting language. (PHP, n.d)

MySQL

MySQL is an open-source relational database management system and is owned by Oracle Corp. The system is used to modify the database, sharing similarities with structured query language (SQL). MySQL is used for various applications, but it is especially popular with web servers. A website using MySQL may include web pages that have information coming from a database. (MySQL, n.d)

4.2 Database diagram

To build the LMS to correspond to all the objectives and deliverables drafted in project planning, a database should be designed appropriately. A database designed beforehand helps to improve the project's quality in terms of information infrastructure. A draft of the database can be found in the figure below (Figure 5):

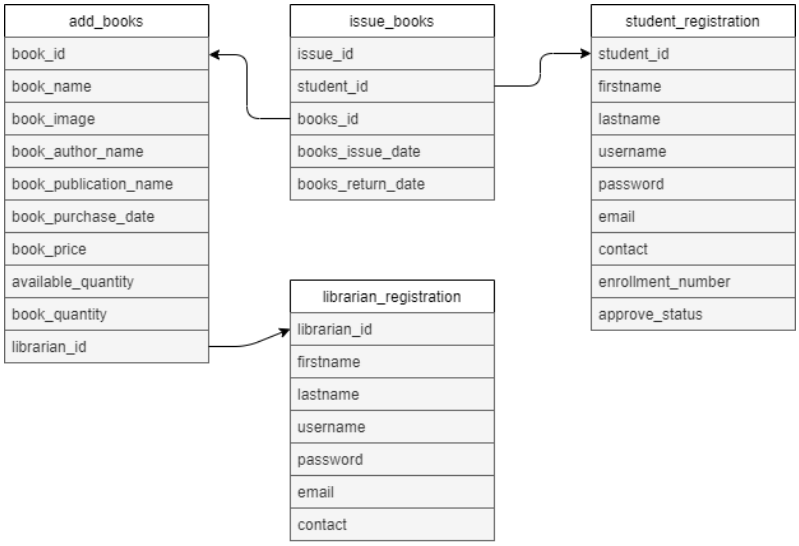

Figure 5. Database relationship.

4.3 Sketching the user interface wireframes

As mentioned in chapter 3.2 about quality management methods, the use of a user interface wireframe has significant impacts on improving the appearance of a project. The author used the Balsamiq Wireframes application to make wireframes for the LMS. To obtain the deliverables discussed in project planning, the LMS needs different web pages that provide diverse functionalities. Some of these wireframes are demonstrated in Figure 6 and Figure 7 below. Figure 6 illustrates the planned look of the login page, while Figure 7 shows a rough demonstration of the front page of the admin user.

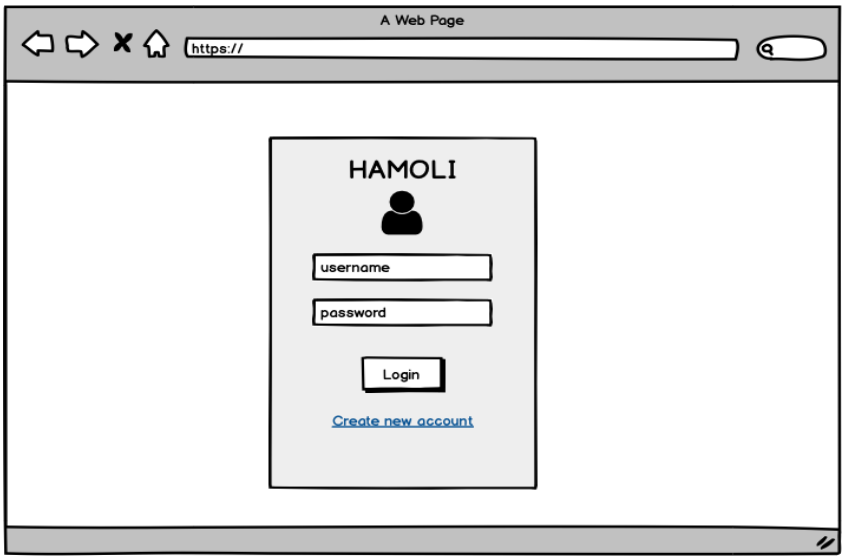

Figure 6. Login wireframe.

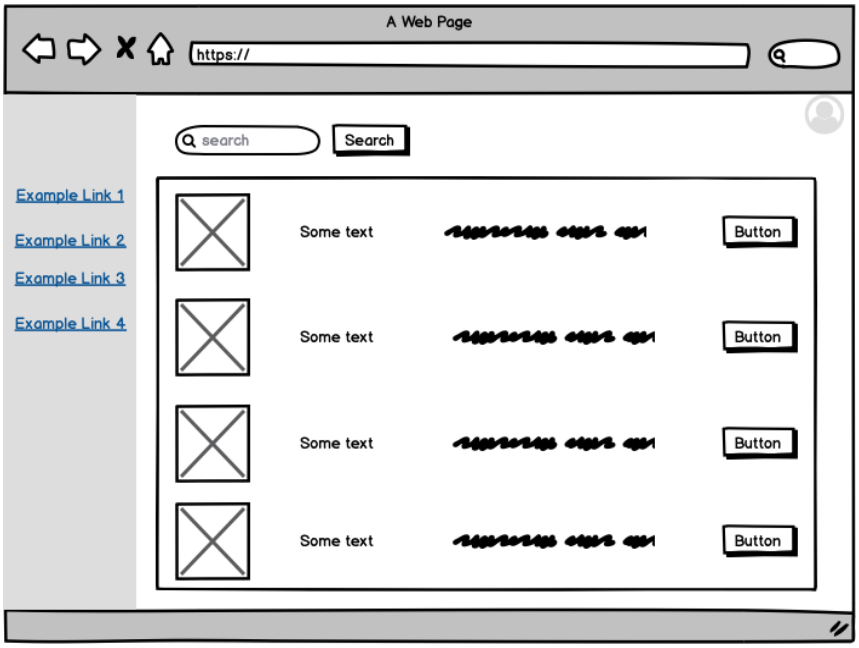

Figure 7. Dashboard wireframe.

4.4 Implementation of Library Management System

4.4.1 Set up the environment

In this project, the project owner specifically requested the possibility of running the application on a local server after it is finished. This specification was noted as a deliverable and a project objective. Thus, the author ordered a cloud service with comparable specifications to the computer it will run on once the project is released. This cloud service got set up with an Nginx web server as well as a MariaDB instance for the underlying database structure. With these lightweight services, the project is optimized for low specifications and thus easy to transfer to basically any modern machine.

4.4.2 Admin user

Login

This is the first view when the user first accesses the application. The user is required to fill in his username and password in order to use the LMS's functions. There are two types of users: admin and student. The login page for the two subjects differs slightly.

The student view has the option of registering for an account, while the admin view does not, as there is only one admin who would be managing this specific application in the Japanese laboratory. The login page for the admin can be seen in the following figure (Figure 7):

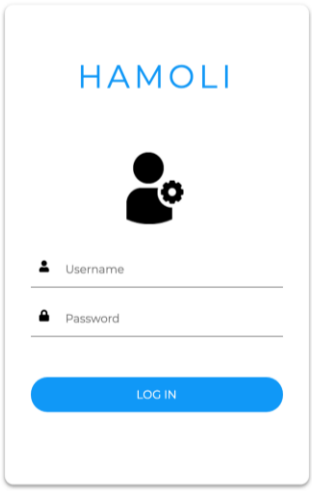

Figure 8. Admin login.

The login page was made with PHP code, including a HTML layout styled by CSS and Bootstrap. The login function from PHP checks if the input from the user matches the registered data from the database. If one of the two fields does not correspond to this condition, an error message will be displayed to inform the user. The password field is well encrypted with password_hash() function which is a built-in function in PHP language (Figure 9):

```php
<?php
if (isset($_POST["submit1"])) {
    $epass = password_hash($_POST["password"], PASSWORD_DEFAULT);
    mysqli_query($link, "INSERT INTO student_registration VALUES('','$_POST[firstname]','$_POST[lastnam
e]',
    '$_POST[username]','$epass','$_POST[email]','$_POST[contact]','', '$_POST[enrollmentno]','no')");
}
?>
```

Figure 9. Encrypting password function example.

Admin homepage

The first page the admin user will see after logging in is a page that displays all the books the library holds. Figure 10 demonstrates the visuals of this page. On the left side, there

is a navigation sidebar that helps to direct to different pages of the application. The top right corner displays a user icon, indicating the place for the admin user to change his personal settings. To quickly search for certain books, the admin can easily do that by using the search bar at the top of the page. Below the search bar, all books are displayed in a table format. Each book has an image of their front cover together with basic data about their name, author, publication name, date of purchase, price, total quantity, available quantity and the option to delete a book from the database. By being the first page that the admin user comes upon, this page gives a brief overview of the availability of the books in the library. Moreover, the admin user has full control over updating the status of the database so that it is up-to-date with the existing number of books in the library.

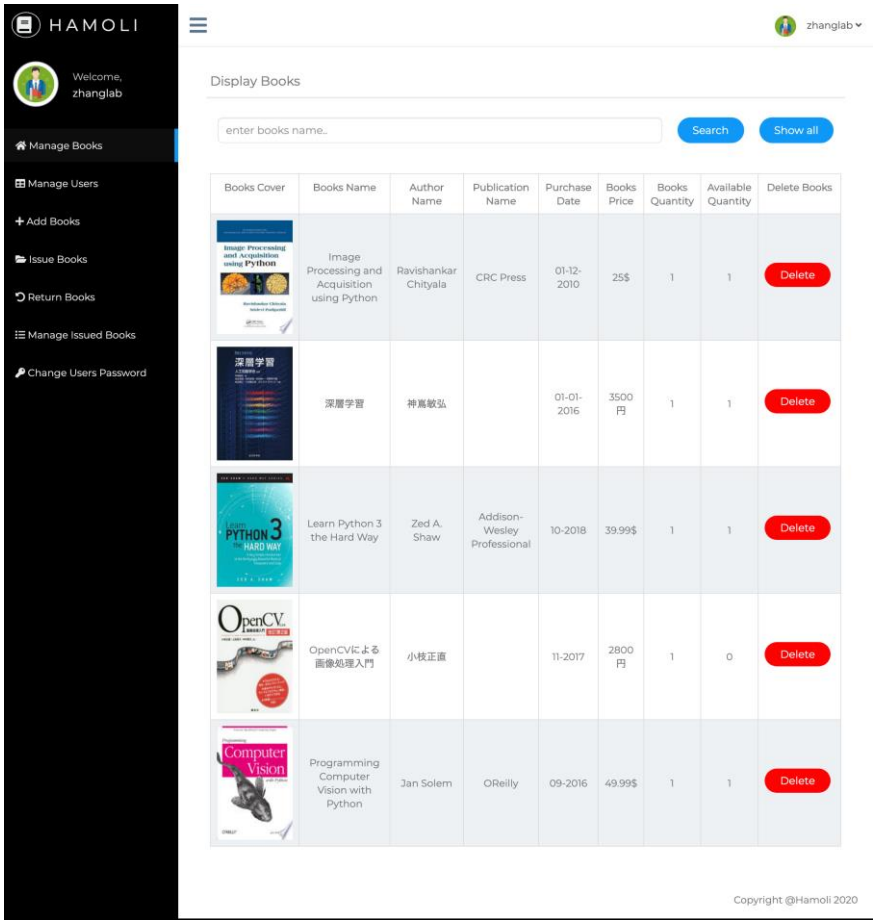

Figure 10. Admin's homepage.

Manage users

The admin can easily see student users' information by choosing Manage Users from the navigation sidebar. This function helps the admin to see which students are using the system, as well as the students who have registered to become a user of the system. As an admin user, the admin has the option to approve or disapprove a user's registration. This helps to disable unwanted registration from unknown users, thus preventing them from exploiting the LMS for unwanted purposes. The status column displays the eligibility of student users towards the usage of the LMS. The conditional statement to approve the student's status is done relatively simply with PHP, shown in the snippet below in Figure 11.

```php
<?php
  include "connection.php";
  $id =$_GET["id"];
  mysqli_query($link, "update student_registration set status='yes' where id=$id");
?>
```

Figure 11. Approving a student's status.

This status will be considered in the login function of the student when he attempts to log into the system (all the data displayed in Figure 12 is for demonstrating purposes only and it was generated randomly).

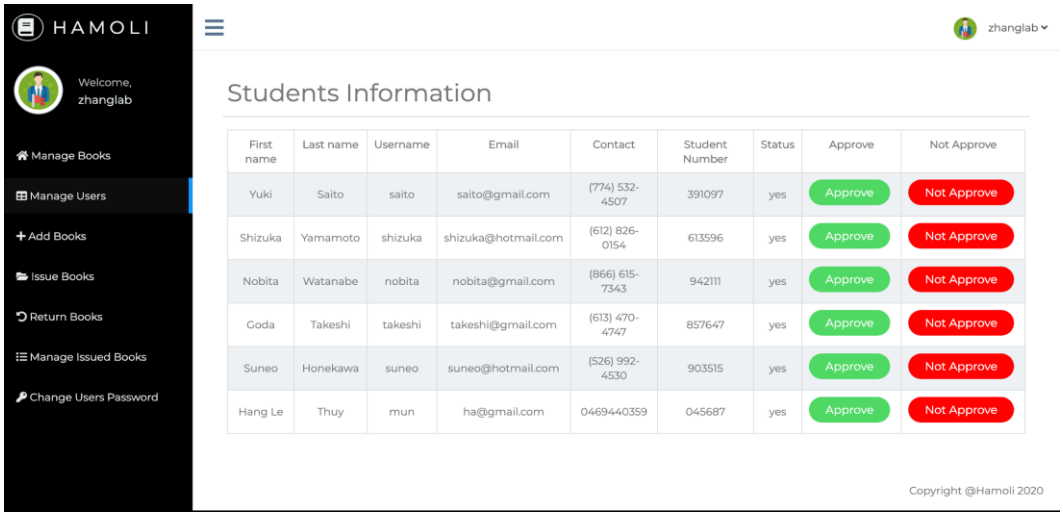

Figure 12. Manage users page.

Add books

A vital function of any LMS is the ability to add new books. To make the process easier, the author implemented a function to help the admin user add books easily by adding only the International Standard Book Number (ISBN), which can normally be found on the back cover of any books. The system retrieves information from Google Books API, an API that aims to make the world's books more easily discoverable online (Google, 2019). Certain information can be obtained from Google Books API, such as the book's name, cover image, author's name, publication's name, and sometimes even the book's price. The admin user only needs to fill in the date of purchase, the quantity and the available quantity of the book in the library at the time of filling. In case the ISBN does not exist in Google Books API, the admin user can also fill in all the information manually and upload the book's cover image from his computer.

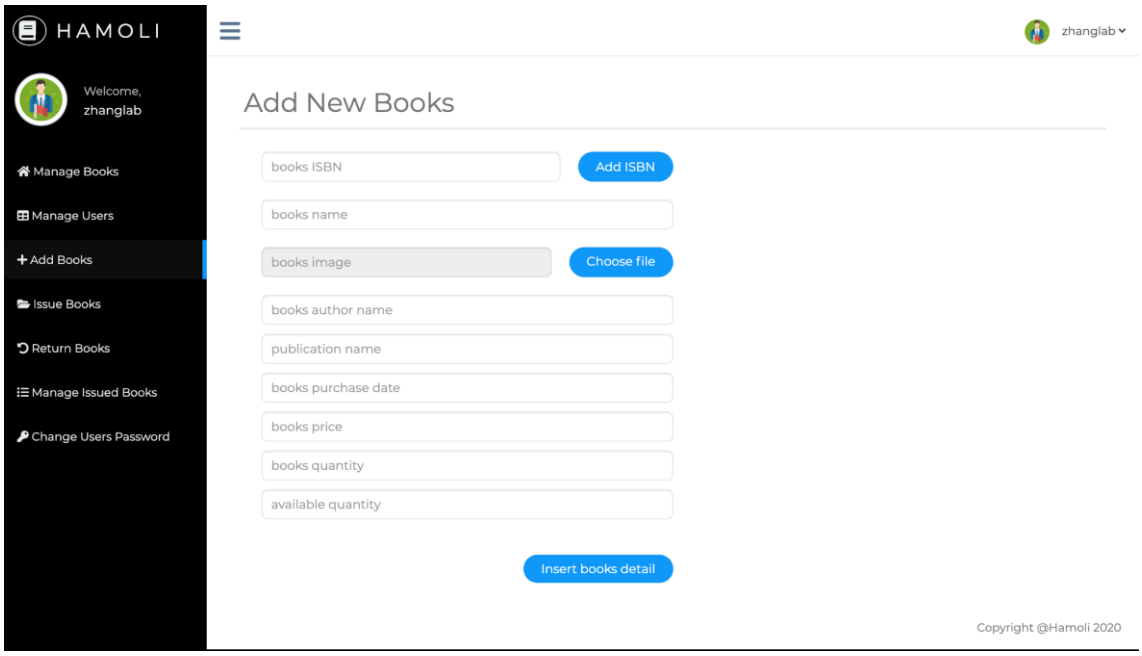

Figure 13. Add books page.

The code below in Figure 14 shows the function that retrieves data from Google Books API by using ISBN.

```php
<?php
function getBookData($isbn){
$url = "https://www.googleapis.com/books/v1/volumes?q=isbn:$isbn" . "&country=US";
  $result = file_get_contents($url);
  $response = json_decode($result, true);
  $title = $response["items"][0]["volumeInfo"]["title"];
  $author = $response["items"][0]["volumeInfo"]["authors"][0];
  $thumbnail = $response["items"][0]["volumeInfo"]["imageLinks"]["smallThumbnail"];
  $published = $response["items"][0]["volumeInfo"]["publishedDate"];
  $publisher = $response["items"][0]["volumeInfo"]["publisher"];
  $price = $response["items"][0]["saleInfo"]["listPrice"]["amount"];
  $currency = $response["items"][0]["saleInfo"]["listPrice"]["currencyCode"];
  $array = [
    "title" => "$title",
    "authors" => "$author",
    "thumbnail" => "$thumbnail",
    "published" => "$published",
    "publisher" => "$publisher",
    "price" => "$price $currency"
  ];
  return $array;
}
```

Figure 14. Get book's data by using ISBN function.

Issue books

To issue a book loan, the admin user can navigate to Issue Books page. By choosing the student number, the admin can issue the books that the student is interested in. The student's information is retrieved from the database. The student number and username are fixed in the issuing view. If the book is not available, a notification will pop up to announce that the wanted book is not in stock.

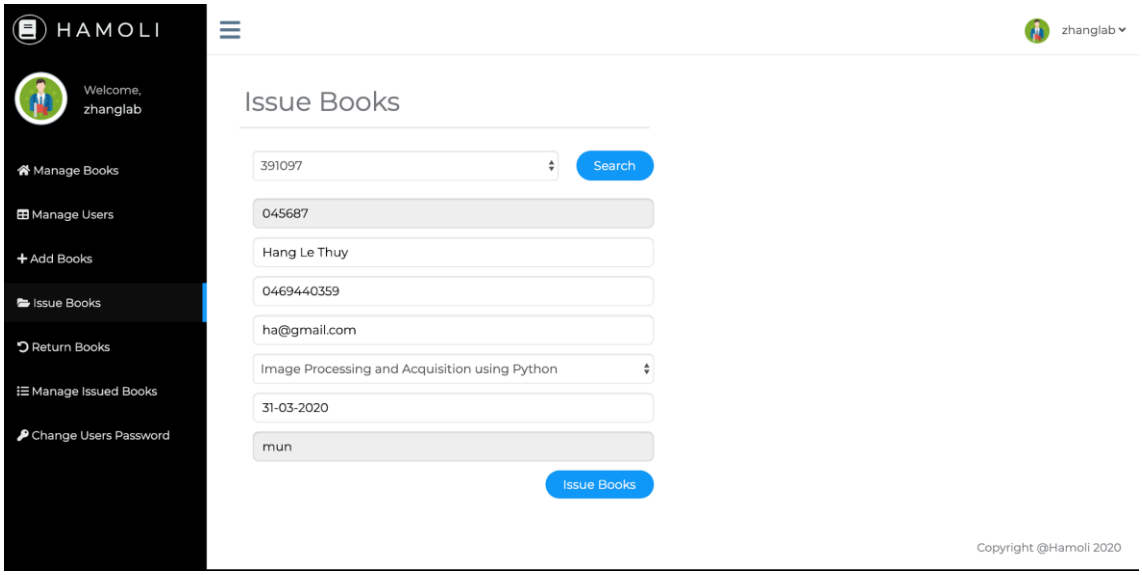

Figure 15. Issue books page.

Return books

Sharing the same concept with Issue Books, the page for returning books also begins with choosing the student number. However, the list of student numbers in the Return Books page only consists of those that have had books issued in the past. By clicking the Return button, the database will be notified about the status change in books' availability.

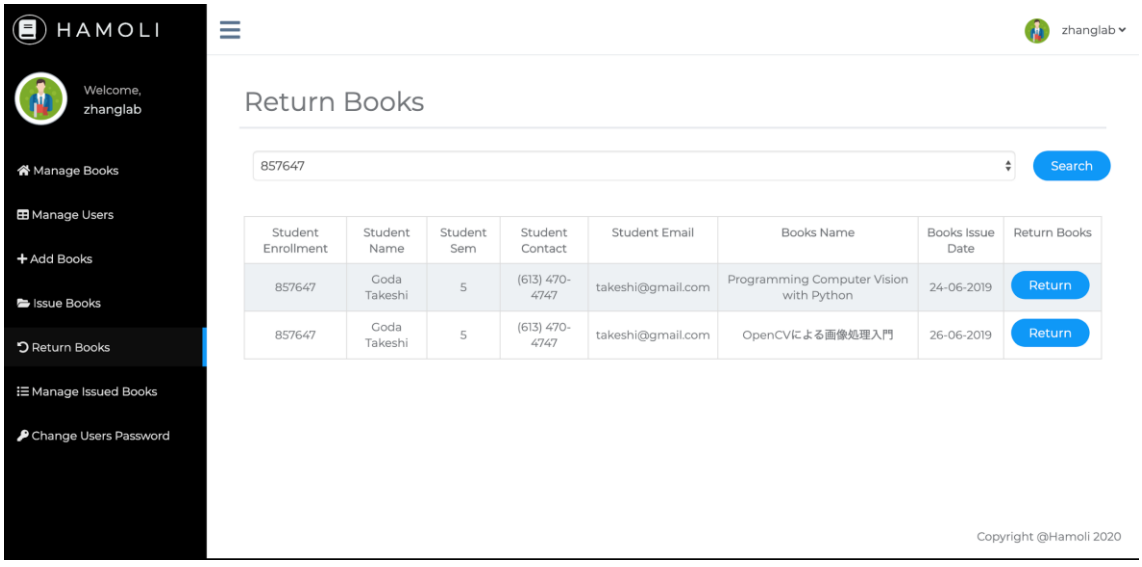

Figure 16. Return books page.

Manage issued books

To see which books students have borrowed, the admin user can visit the Manage Issued Books page. This page displays all the books' records that are associated with the student's book issuing. By clicking See student's record button, the admin grasp a quick overview of the book's whereabouts.

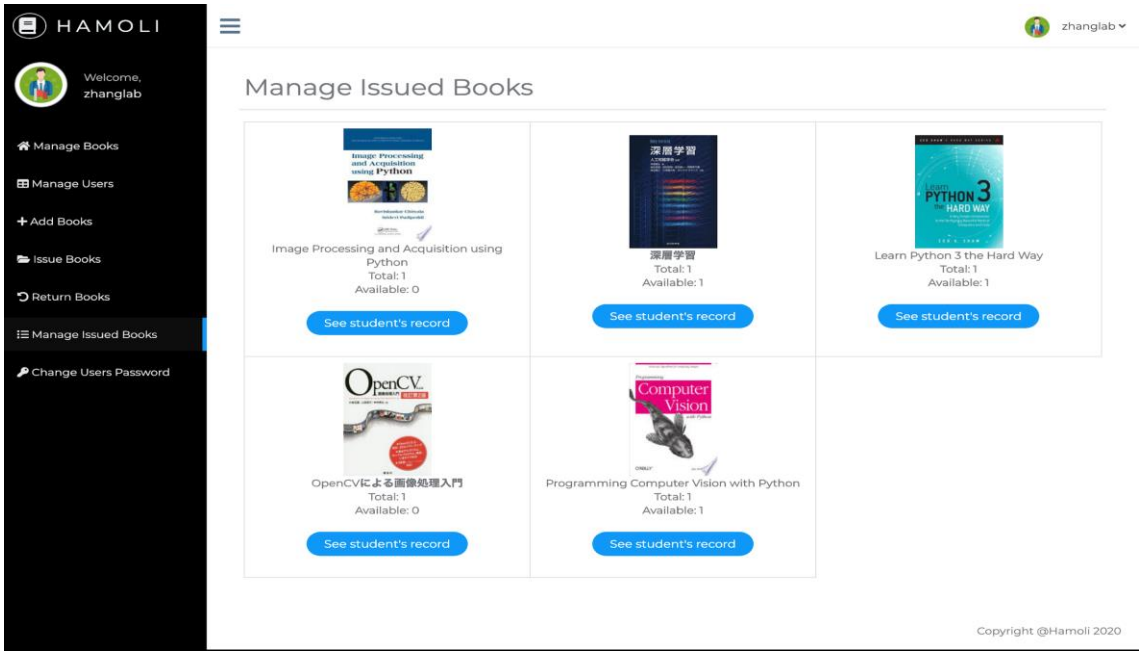

Figure 17. Manage issued books page.

Change User's Password

Due to the relatively short allocated time dedicated for developing the application, accompanied by the project owner's wish to run the application from a local server, the LMS was developed in a way that when a student forgets his password, he can only reset it by approaching the admin user who resets the student's password from the admin user view.

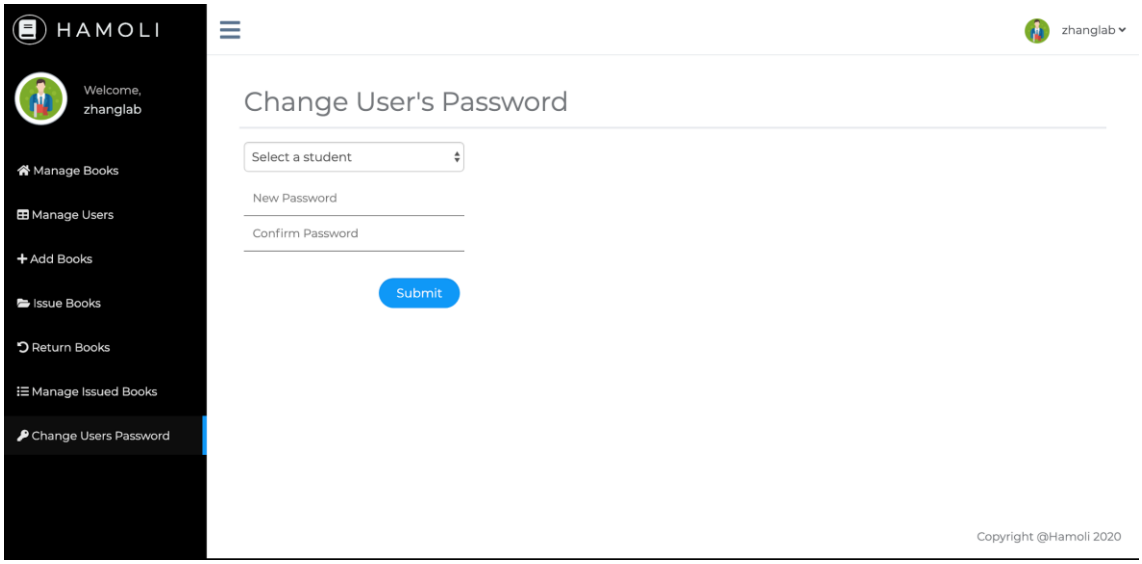

Figure 18. Change user's password page.

Dropdown menu

The dropdown menu contains basic functions that help the user to be in charge, such as changing his profile picture, changing his own password or logging out of the application. These functions took a short time to develop, but nonetheless are essential in any application that involves a user's profile.

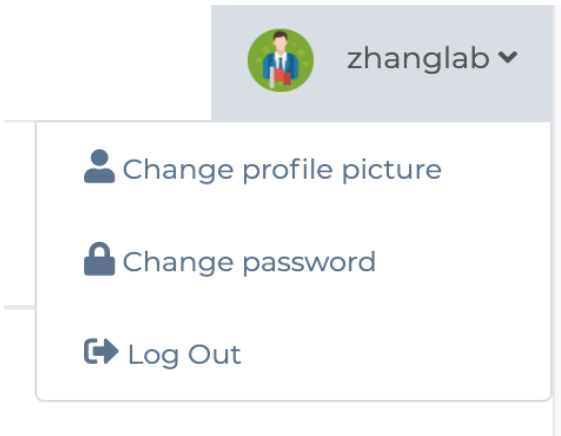

Figure 19. Dropdown menu for admin.

4.4.3 Student user

Login

As stated in the login page for the admin user, the student login has an option to register for a new account. Other than that, the student login page is almost entirely identical to that of the admin user, meaning it shares the same functionality and user interface with the admin user, as shown in the figure below (Figure 20):

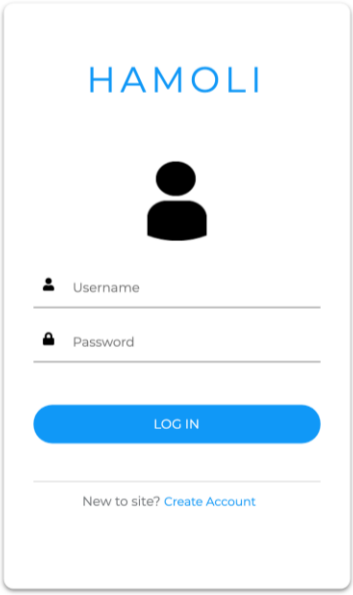

Figure 20. Student login.

Student registration

A student from the laboratory can register to be a user of the library application service. By coming upon the login page, a new student will see the option “Create account” to sign up for a new account. However, the student may only log in to the LMS after the admin has approved his registration. All of the registration information will be saved to a database table named “student_registration” which was demonstrated in the database relationship diagram in Figure 4. The information from this table is retrieved numerous times within the admin user view, for multiple purposes such as issuing books, returning books, seeing student’s records, etc. The next figure (Figure 21) shows the view of a student’s registration form.

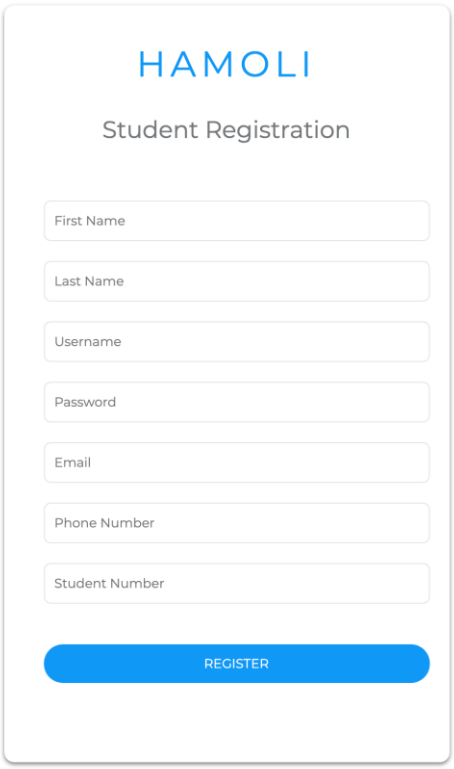

Figure 21. Student registration.

Student homepage

After successfully registering an account that has been approved by the admin user, a student can log in to the application using his chosen username and password. The first view a student will see in the application is the list of loans that he has from the library. The homepage will tell the student which books he has borrowed and the issued dates of these books. The student page's structure is similar to the admin's one, with a navigation sidebar on the left, a dropdown menu on the right and the main content in the middle of the page.

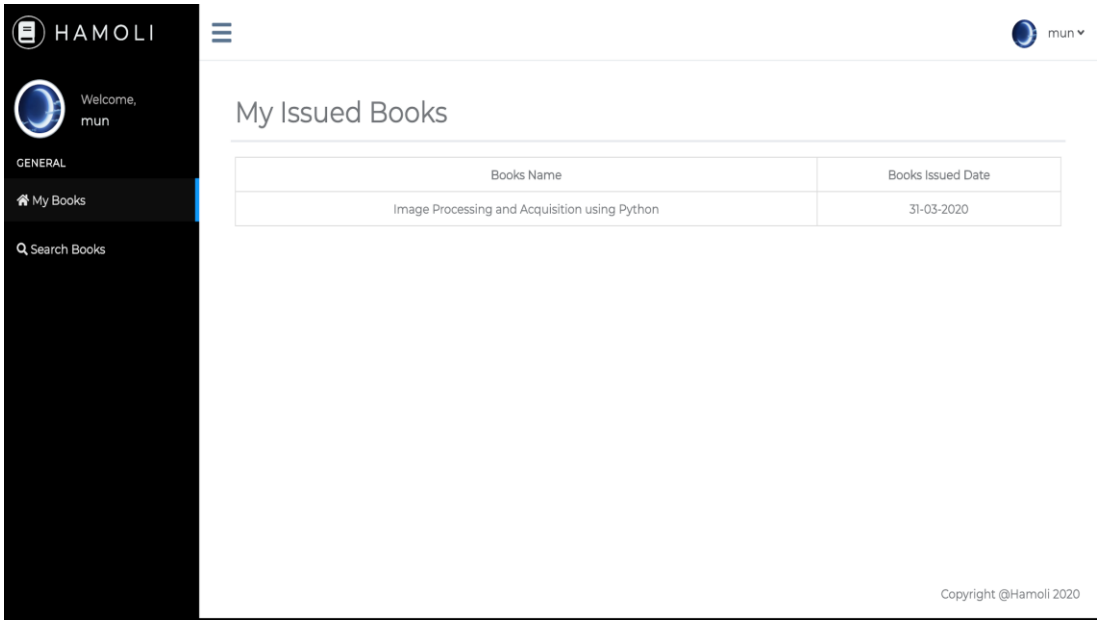

Figure 22. Student homepage.

Search books

By navigating to the Search Books tab on the navigation sidebar, the student will see all the books the library has. By looking at the available quantity of books, the student will have a quick overview of what books are currently available at the library and proceed to borrow the ones he needs. The interface of this page is similar to the home page of the admin user, with a search bar to get quick access to certain books that contain the desired keywords.

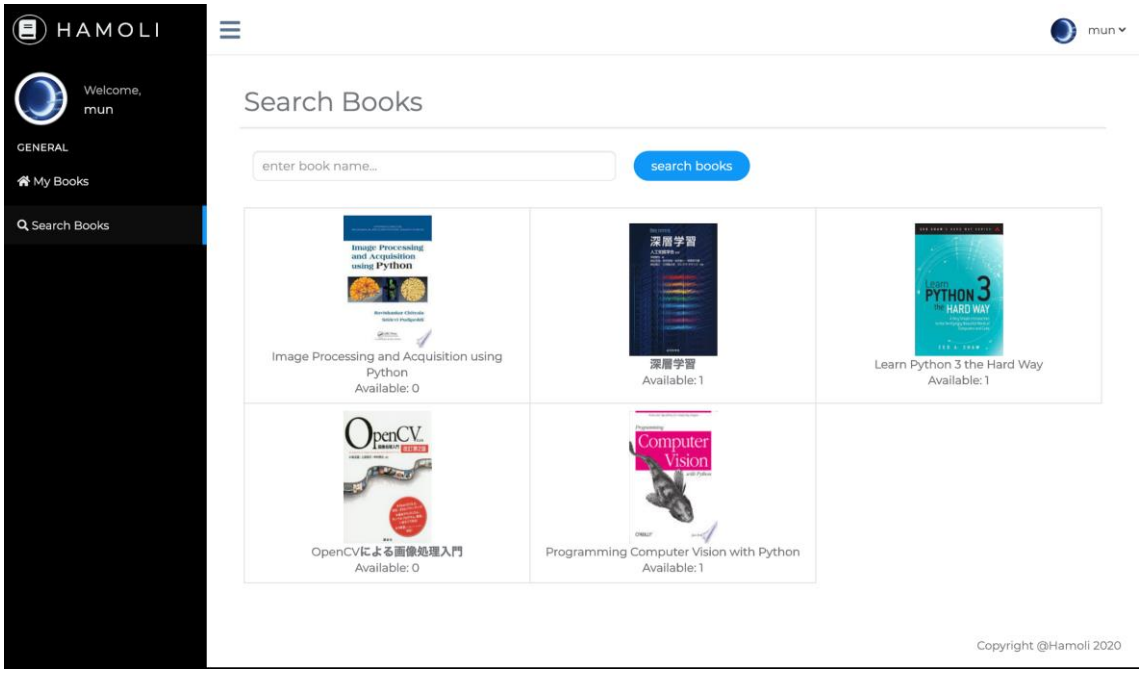

Figure 23. Search books page.

Dropdown menu

Equivalent to the admin user's page, the student's view also possesses a dropdown menu with basic functions: change profile picture, change password, log out of the application.

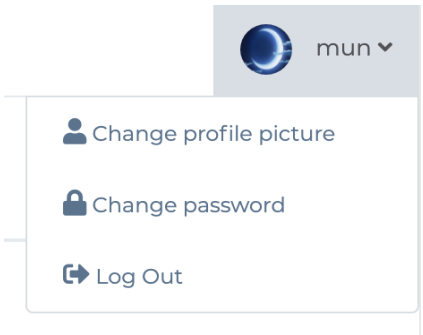

Figure 24. Dropdown menu for student.

5 CONCLUSION AND RECOMMENDATION

This chapter aims to summarize the overall effects of project planning and quality management on the LMS. To be specific, the objectives for the LMS introduced at the beginning of this thesis will be addressed in order to evaluate the accomplishments of the project. Furthermore, the final part of this chapter offers recommendations for advancing the application in project planning, quality management as well as the application's features.

5.1 Conclusion

5.1.1 Project planning

Project planning assisted the project in various ways. Had it been without project planning, the project would have faced tremendous obstacles because of the lack of a proper guideline. Thanks to the clear deliverables stated in the project plan as well as the estimated schedule, the author was able to carry out the execution of the project correspondingly. The risk and contingency analysis helped to predict the possible risks, thus giving the author a realistic expectation of how it might turn out. The allocated extra time in the project plan allowed the project to be closely tested before delivering it to the project owner. The project plan drew a good picture of what tasks needed to be fulfilled before it was eligible to close the project.

5.1.2 Quality management

Following quality management question lists and best practices, the project was attentively taken care of. Throughout the project, the author managed to improve the quality of the project in both technical and non-technical aspects. In the technical side, the application's appearance, testing, security and code's structure were enhanced. As it is evident from the project's illustrations, design consistency was implemented by keeping the look of elements of the same group uniform through different pages of the application. The user interface was improved gradually and noticeably by the knowledge gained from numerous sources. Each function was tested thoroughly right after it was

implemented, resulting in less debugging time. Sensitive information such as user's password was well encrypted, thus ensuring user's privacy. Code structure and web accessibility were carefully handled. In the non-technical side, emphasis was put on communication, the time-frame and the documentation of the project. Communication with the project owner was prioritized, as communication is arguably one of the key factors that determine a project's success. For instance, thanks to continuous back-and-forth communication, the author was given instruction on the project owner's wish of implementing the adding books function with ISBN. By paying attention to the quality checklist questions, the author managed to close the project with a final report within the three-month time frame. All necessary documentation related to the project was properly finished and well stored.

5.1.3 Library management application

The LMS, in general, has accomplished the objectives mentioned at the introduction of this thesis:

To create an admin user with administrative functions in order to manage books, issue books and keep track of records efficiently.

The LMS has an admin user view with all the managing functions that meet the requirements mentioned above, which helps the admin user to save time substantially and makes the administrative work more efficient.

To help students view the available books and manage their book loans.

The student view of the application has the exact two functions. These functions assist students in books' loans digitally, which saves time and makes it easier to access the library's availability.

To build a product that can run locally on the supervisor's computer.

At the end of the three-month period, the author compressed all the files and database then sent it to the project owner including instructions for him to set up the application on his local machine. The project owner was reportedly happy with the instructions and the files.

To make sure the application is easy to use with logical connections between different functions.

All the existing functions have been thoroughly tested. There is room for improvement, but in general, the application works as expected and delivers the desired functions smoothly. The application is relatively simple to learn to take full control of. It has been taken over by the project owner shortly after its completion.

5.2 Recommendation for further development

For project planning, a Gantt chart could be used to estimate time and draw the schedule. A Gantt chart helps to illustrate the project schedule more efficiently because one can select the filter to see the schedule by day, week, month, quarter and year. Moreover, dependencies between tasks can be easily managed with the help of a Gantt chart.

In terms of quality management, the project might benefit from the following suggestions. Code refactoring which involves deleting unnecessary code may help to improve the application's speed considerably. The code used in the application should be minified as much as possible in order to boost its processing time. If it is convenient and technically possible, the application should use the most up-to-date software versions to make the best use of security fixes. User experience testing may be conducted to improve the application's features and flow.

The application can certainly be improved by implementing a "Did you forget your password" feature that allows users to reset their password through an email link invitation. This change would enhance the user experience. In addition, it would help the application to be on par with modern practices.

More useful library-related features can be added. As the world moves forward to be more and more digitized, a reasonable expansion for the application would be the availability of e-books and audiobooks.

If the application is adopted by larger libraries with a significantly larger number of books in storage, a barcode scanner should be integrated into the LMS. Doing so would save a remarkable amount of time for adding new books to the database. The barcode will be translated into ISBN, which the function in the current LMS will handle the data retrieved from certain books API. Naturally, other book APIs should also be added to the application to make the data source for ISBN more diverse and failproof.

To improve the application in the students' end, a history of books' loans should be in place. Such a feature will help students keep track of the books they have borrowed from

the library, which will be useful in case they need the same books again. Moreover, each book can have tags that are related to their content or genre. After a student borrows a book, similar books may be suggested to that student based on the resemblance in the tags.

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Project plan example

1. Introduction

1.1 Introduction and Project Goal

The Computer laboratory at Sendai National College has a lot of academic books that support students with their study. However, there is no digital system that handles the books' issuing and returning. Hence, the need for a library management system emerges.

The goal of this project is to create a library management system that will help the head teacher of the laboratory to manage books more efficiently. Moreover, the project aims to help the students access the library's availability more conveniently.

1.2 Project Scope and Outcome

- To create an admin user with administrative functions in order to manage books, issue books and keep track of records efficiently.
- To help students view the available books and manage their book loans.
- To build a product that can run locally on the supervisor's computer.
- To make sure the application is easy to use with logical connections between different functions.

1.3 Project limitations

- The application will not be available on an online server, only locally
- The project is optimized for desktop view only, not for mobile view
- The application only has basic functions that were agreed upon before the execution of the project

2. Organization

2.1 Project group

Name	Role	Contact information
Hang Le	Developer, contact person	(Phone number and email address)

2.2 Customer Information

Customer name	Role	Contact information
Zhang. XX	Project owner	(Phone number and email)

3. Project Implementation Plan

3.1 Schedule

- Project start date: 17.04.2019

- Estimated schedule:

  - Researching technology: 2 days
  - Building the database relationship: 3 days
  - Researching about user interface and sketching wireframes: 1 week
  - Setting up the environment: 2 days
  - Developing front-end: 1 week
  - Developing back-end: 3 weeks
  - Reviewing, testing and fixing: 3 weeks
  - Quality testing, presenting the work, closing the project: 1 week

- Final date for delivery of the whole product: 15.07.2019

3.2 Cost Estimate

The project lasts for three months. The total working hours on this project are roughly 400 hours, the cost for one hour work of a student trainee is on average 10 euros. Therefore, the total cost for the project is 4000 euros.

3.3 Resource plan

Name	Hours/week	Notes
Hang Le	37.5	Not available during Japanese Golden week from 29.04.2019 to 06.05.2019

3.4 Software and Hardware

HTML5, CSS3, Javascript (ECMAScript 6), Bootstrap (version 3.3.7), PHP (version 7.0.33), MySQL - MariaDB (version 10.1.41).

3.5 Outcome delivery

All files related to the project including the database file will be compressed and delivered to the project owner through OneDrive.

4. Project management plan

4.1 Meetings and communication

- External communication: The developer and the project owner's main means of communication is face-to-face interaction, because the developer will be working on this project in the Computer laboratory where the project owner is the head teacher. The second means of communication is through emails. At the end of each week, the developer and the project owner has a short meeting (about 30 minutes) to discuss the status of the project and both will decide how to move forward with the project.
- Internal communication: As the developer works alone on this project, there is no defined means of communication.

4.2 Documentation Storage and Code Repository

All documentations will be stored in a OneDrive shared folder. The project's code is available on Github, access to Github is shared with the project owner.

4.3 Project Quality Goals

- The functionalities of the application will be thoroughly tested.
- The user interface will be optimized for desktop view.
- The project follows quality management's checklist

4.4 Project Risk Analysis

Risk name and consequence	**How to avoid**	**Plan B**
Project owner does not offer opinions about the project's design	Make sure to have the meeting at the end of the week with project owner and ask about the design as early as possible	Get design references from reputable sources and build the design based on these findings
Natural disasters (e.g., earthquakes) that may delay or lengthen the project's allocated time	Apply MoSCoW method to implement the most important requirements first	Get more student developers from the beginning of the project
The environment has problems with database connection because of possible updates from the softwares	Set up the environment carefully and stick to best practices, document the software versions accurately	Get familiar with alternatives to the chosen technologies